Effects of Nonnutritive Sucking Habits on Occlusal Characteristics in the Mixed Dentition

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Abstract

Purpose: Little is known about the extent to which nonnutritive sucking habits contribute to malocclusion in the mixed dentition. The purpose of this study was to report on the relationship between certain occlusal traits in the mixed dentition and longitudinal sucking behaviors.

Methods: Dental examinations were conducted on 630 children in the mixed dentition who participated in a large, ongoing longitudinal study. Five hundred eighty consented to impressions, and 524 adequate study models were obtained. Of these, 444 also had adequate longitudinal nonnutritive sucking data obtained via mailed questionnaires to parents at 3- to 6-month intervals from birth to 8 years. Sucking behaviors were grouped by predominant type and duration. Study models were hand articulated using wax bites to evaluate the occlusion for the presence of open bite, crossbite, molar relationship, and excessive overjet. Bivariate statistical analyses related presence of these malocclusions to sucking duration and type.

Results: Fifty-five percent of the children had malocclusions (anterior open bite, posterior crossbite, bilateral Class II molar relationship, or overjet >4 mm). Class II molar relationship was most common (30%). Overall, anterior open bite and posterior crossbite was associated with habits of 36 months or more. Sustained pacifier habits, including those of 24 to 47 months, were associated with anterior open bite and Class II molar relationships, while digit habits were associated with anterior open bite when sustained for 60 months or longer.

Conclusions: Malocclusions are quite prevalent in the mixed dentition, and anterior open bite and posterior crossbite may be preventable by modifying nonnutritive sucking behaviors. (Pediatr Dent 2005;27:445-450)

KEYWORDS: NONNUTRITIVE SUCKING, MIXED DENTITION, MALOCCLUSION

Malocclusions are common in the general population of children, and often require lengthy and expensive treatment to correct. While many malocclusions are believed to be caused by genetic (inherited) factors, some may be caused by environmental factors, particularly nonnutritive sucking behaviors. Since nonnutritive sucking habits are modifiable factors, knowledge of how such behaviors contribute to malocclusion is important in preventing them.

Most studies of relationships between nonnutritive sucking habits and malocclusion have concentrated on the primary dentition, while studies assessing the mixed dentition stage when treatment is typically prescribed are much less common. Among studies of the mixed dentition, a longitudinal study of 116 Australian children from age 2 to 8 years[1,2] found that persistent finger-sucking was related to increased overjet, decreased overbite, and an increased proportion of Class II malocclusions. Pacifier-sucking was significantly associated with reduced arch width, but this generally resolved 2 to 3 years after pacifier-sucking ceased.[2]

According to Bowden, posterior crossbites were not associated with either digit or pacifier nonnutritive sucking

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habits.[1] A retrospective study of orthodontic patients in the mixed dentition stage[3] concluded that posterior crossbite was no more prevalent among children with a history of pacifier use or finger-sucking habit than among children with no history of such habits.[3] Finally, a Danish study[4] of 10- to 11-year-old children found that nonnutritive sucking habits (either digit or pacifier) resulted in greater persistence of a tongue-thrust swallowing pattern, which, in turn, was associated with Class II malocclusions, extreme maxillary overjet, and open bite.[4]

The limited number of studies has provided useful information. In general, however, they have used one-time retrospective questionnaires to characterize the presence or absence of sucking behaviors; the validity of such sucking data is somewhat questionable. Moreover, the use of single retrospective questionnaires makes it difficult for parents to accurately assess the duration of habits, and in turn, makes it difficult to assess their effects on occlusion.

The purpose of the present study was to assess the relationship between different types of malocclusion and nonnutritive sucking history, using longitudinally gathered nonnutritive sucking data.

Methods

The data for the present study were obtained from the Iowa Fluoride Study cohort. The longitudinal Iowa Fluoride Study,[5-8] begun in 1991, originally recruited over 1,300 healthy newborns from 8 Iowa hospital general postpartum wards. At recruitment, demographic and social data were obtained for participating families, including family income levels, parental education, birth order, and family size. Data concerning patterns of nutritive and nonnutritive sucking were collected on an ongoing basis along with the other data when children reached the ages of 6 weeks, and 3, 6, 9, 12, 16, 20, 24, 30, 36, 42, 48, 54, and 60 months, and yearly thereafter.

Questions posed to the parents (usually mothers) included ones concerning the children's nonnutritive sucking habits during the previous time period. Specifically, questions about nonnutritive sucking asked whether the child had any sucking habit and, if so, asked the parent to identify objects on which the child sucked from a list which included thumb, other fingers, pacifier, toys, blanket, and "other" objects. Due to the large number of subjects involved and the long-term, multidisciplinary nature of the study, it was not feasible to directly validate the data concerning time engaged in sucking behaviors. Although the sucking behavior data have not been directly validated, they have, however, been clarified by postcard, letter, or telephone when necessary (approximately 8% of total responses), with the questionnaires having been systematically reviewed by at least 2 study team members prior to data entry.

The nonnutritive sucking data were categorized as either predominantly pacifier or digit habit based on these responses. In a few cases (N=33), the duration of habit was less than 12 months and parents either consistently re-

ported no habit or consistently reported both a pacifier and digit habit. These cases with minimal habit duration were included for analysis in both habit type groups. The duration of nonnutritive sucking was determined from the data based on the latest time period, which reported a nonnutritive sucking habit. Duration was categorized in 2 ways for analysis. The primary categorization was less than 36 months, 36 to 59 months, or 60 months or more. Due to the distribution of pacifier habit duration, with relatively few with such habits beyond 60 months, pacifier habits were recategorized as less than 24 months, 24 to 47 months, or 48 months or more.

As part of the Iowa Fluoride Study, dental examinations were conducted on cohort children in the primary dentition (ages 4 to 5),[5-8] and the mixed dentition (ages 8 to 9). At the time of these exams, alginate impressions of the maxillary and mandibular arches were made on children who consented and were able to participate. Those who gagged excessively, had special needs, and/or were unable to cooperate were excluded. An additional exclusion criterion for the primary dentition exams was the presence of one or more permanent teeth, while for the mixed dentition exams there were no additional exclusion criteria. The present study reported on the results of the mixed dentition assessments.

For both exams, wax bite registrations were also made for each child by placing a wax bite wafer on the maxillary teeth and assisting the child to bite in centric occlusion. After the impressions were made, the models were poured in yellow dental stone, labeled, and trimmed to centric occlusion using the wax bite registration. The models were hand articulated using the wax bites and assessed for the presence or absence of anterior open bite, anterior crossbite, posterior crossbite, and permanent first molar relationship. Measurements of overjet and overbite were made directly from the casts using digital dial calipers accurate to 0.05 mm (Mitutoyo Corporation, Tokyo, Japan). Measurements were made in millimeters (mm) and read directly from the calipers.

Nonnutritive sucking data were entered into a relational database and converted to SAS[9] statistical software for categorization. Data from study models were entered in SPSS[10] statistical software, and all data were subsequently merged into SPSS for analyses. Each malocclusion (anterior open bite, anterior crossbite, posterior crossbite, and permanent first molar relationship) was entered as present or absent, with a separate variable created to denote that one or more of these malocclusions were present. Using the categories of sucking duration and predominant habit described above, groups were compared using chi-square analyses. Analyses also utilized *t* tests to compare sucking durations between those with and without specific malocclusions. In a similar manner, *t* tests were used to compare sucking durations between those with 1 or more malocclusions to those with no malocclusions. Significance was predetermined at $P<.05$.

All procedures were reviewed and approved by the Institutional Review Board at the University of Iowa, Iowa City, Iowa. All procedures, possible risks or discomfort, and possible benefits were explained to each subject, and informed consent was obtained prior to enrollment and at each examination.

Results

A total of 580 cohort children consented to participate in the assessments of the mixed dentition. From these, 524 usable sets of models were obtained. Of the 56 for whom models were not obtained, 18 were in active orthodontic treatment, 29 gagged on the impression or otherwise did not complete the impressions, and for 9 the models were broken or had large voids. Of the 524 with usable models, 454 had longitudinal nonnutritive sucking data that was sufficient to characterize the duration of the sucking behavior. An additional 10 cases were excluded because they had previously completed orthodontic treatment, so that the final sample included 444 cohort children. The children ranged in age from 7 to 11 years, with nearly 90% being either 8 or 9 years old. The mean age was 8.6 years.

Fifty-one percent of children had a predominant digit habit, while 42% predominantly had a pacifier habit and 7% reported either no habit or a short duration of both habit types. Among those with either a pacifier or digit habit, the mean duration of habit was significantly longer (P=.001; t test) for digit habits (33 months) than for pacifier habit (14 months).

Table 1 depicts the prevalence of selected malocclusions as related to the duration of nonnutritive sucking habits. For anterior open bite and posterior crossbite, prevalence increased significantly with longer duration of sucking. For excessive overjet and bilateral Class II molar relationship, prevalence was similar for the less-than-36-months and 36-to-59-months groups, but was higher for the 60 months or more group, although neither of these differences was

Table 1. Comparison of the Prevalence of Occlusal Characteristics by Duration of Any Habit Using Chi-square Analysis							
	Group 1 (<36 mos; N=344)		Group 2 (36-59 mos; N=51)		Group 3 (≥60 mos; N=49)		
Characteristic	N	%	N	%	N	%	*P* value
Anterior open bite	13	4%	6	12%	13	27%	<.001
Posterior crossbite	32	9%	9	18%	10	20%	.025
Excessive overjet (≥4 mm)	99	29%	14	28%	19	40%	.254
Bilateral Class II molar relationship	100	29%	15	29%	19	39%	.380
One or more of the above*	181	53%	26	51%	37	76%	.009

*Note that individual children could have more than 1 malocclusion, so that percentages total more than 100%.

Table 2. Comparison of the Prevalence of Occlusal Characteristics by Duration of Pacifier Habit Using Chi-square Analysis							
	Group 1 (<24 mos; N=131)		Group 2 (24-47 mos; N=76)		Group 3 (≥48 mos; N=13)		
Characteristic	N	%	N	%	N	%	*P* value
Anterior open bite	3	2%	6	8%	3	23%	.004
Posterior crossbite	12	9%	10	13%	3	23%	.266
Excessive overjet (≥4 mm)	33	25%	15	20%	4	31%	.608
Bilateral Class II molar relationship	28	21%	25	33%	7	54%	.017
One or more of the above*	60	46%	38	50%	10	77%	.099

*Note that individual children could have more than 1 malocclusion, so that percentages total more than 100%.

Table 3. Comparison of the Prevalence of Occlusal Characteristics by Duration of Digit Habit Using Chi-square Analysis							
	Group 1 (<36 mos; N=194)		Group 2 (36-59 mos; N=17)		Group 3 (≥60 mos; N=46)		
Characteristic	N	%	N	%	N	%	*P* value
Anterior open bite	7	4%	1	6%	12	26%	<.001
Posterior crossbite	17	9%	2	12%	9	20%	.106
Excessive overjet (≥4 mm)	63	33%	6	35%	19	43%	.402
Bilateral Class II molar relationship	59	30%	5	29%	17	37%	.679
One or more of the above*	107	55%	9	53%	34	74%	.061

*Note that individual children could have more than 1 malocclusion, so that percentages total more than 100%.

statistically significant. On the other hand, there is a significant and dramatic increase in the prevalence of malocclusion if the habits persist after 5 years.

Tables 2 and 3 present results for pacifier habits and digit habits, respectively. Pacifier habits of 48 months or more had a significantly higher prevalence of open bite and bilateral Class II molar relationship than the shorter-duration groups. Posterior crossbite and excessive overjet were generally more prevalent with longer duration of habit, but neither of these relationships was statistically significant. For digit habits, anterior open bite was much more prevalent among those with habits of 60 months or longer

(*P*<.001). Other conditions were generally more prevalent with longer digit habit duration, but none reached statistical significance.

The results of *t* test comparisons of the mean habit duration in subjects with and without specific types of malocclusion, along with the prevalence of different occlusal characteristics, is presented in Table 4. For each of the occlusal characteristics, mean habit duration was longer for those with the characteristic than those without. For anterior open bite, posterior crossbite, and any of the 4 selected characteristics, mean habit duration was significantly longer for those with the characteristic compared to those without the characteristic. Additional analyses (data not shown) which considered pacifier and digit habits separately found that, in all instances, those with a given characteristic had longer habit durations than those without the characteristic. The only statistically significant difference, however, was among those with and without anterior crossbite and a history of digit habits.

Discussion

The present findings indicated that longer nonnutritive habit durations were associated with higher prevalence of malocclusion in the mixed dentition. In general, longer habits were associated with anterior open bite and posterior crossbite. More specifically, prolonged pacifier habits were associated with anterior open bite and bilateral Class II malocclusion, while prolonged digit habits were associated with anterior open bite.

Such findings are not surprising, as numerous studies[1-4,7,8,11-26] —some dating to the 1800s[11,12]—have linked nonnutritive sucking habits to malocclusion. What is unique about these findings is that, with the longitudinal study design that employed sequential questionnaires, the study was able to quantify habit durations. Moreover, as a result of the relatively lengthy study duration, it was possible to track the consequences of the habits into the mixed dentition stage of the children evaluated. Thus, the study was able to assess the effects not only of ongoing habits, but also the effects of relatively prolonged habits that were discontinued several years prior to the mixed dentition assessments. Therefore, the more important findings of the study are not that prolonged habits result in malocclusion, but that prolonged habits—even when they are discontinued during the primary dentition stage—sometimes can result in malocclusion. In other words, the risk for malocclusion appears to increase with longer habit duration, so that, while in some cases malocclusions resolve soon after the habits are discontinued, in other cases the malocclusions persist.

The present findings support earlier findings reported on the primary dentition for the same cohort[7,8] and suggest that previous recommendations regarding nonnutritive habit discontinuation may need to be revisited. For example, the American Academy of Pediatric Dentistry states on its Web site, "for most children, there is no reason to worry about a sucking habit until the permanent front teeth are ready to come in."[27] Similarly, the American Dental Association states on its Web site, "after the permanent teeth come in, sucking may cause problems with the proper growth of the mouth and alignment of the teeth…children should have ceased sucking by the time the permanent front teeth are ready to erupt."[28]

While such recommendations may help to prevent many sucking-induced malocclusions, the results of the present study suggest that nonnutritive sucking habits discontinued at 3 to 5 years of age may still lead to malocclusion in a certain proportion of cases. Thus, to prevent more malocclusions caused by nonnutritive sucking habits, recommendations should be revised to advocate cessation of habits prior to age 3 and emphasize that the earlier a habit is ceased after age 3, the less risk for development of malocclusions due to habits.

While the findings of the present study support the findings from the same cohort in the primary dentition and support recommendations for early cessation of nonnutritive habits, there are some subtle differences between findings for the primary and mixed dentitions. For example, the overall prevalence of overjet of 4 mm or greater increased from 10% in the primary dentition to 30% in the mixed dentition, but was not related to nonnutritive sucking duration in the mixed dentition as it was in the primary dentition.[7] Similarly, while the overall prevalence of anterior open bite was similar between the primary and mixed dentitions (8% vs 7%), the trend towards increased prevalence with greater duration of nonnutritive sucking habits was not as pronounced in the mixed dentition, particularly for digit habits.[8]

The difference in proportion with at least 4 mm of overjet may be due to the general increase in size of the children, in that 4 mm represents a relatively smaller proportion of arch size for children in the mixed dentition compared to

Table 4. Prevalence of Different Occlusal Characteristics and Results of *t* Test Comparisons of the Habit Duration in Subjects With and Without Specific Types of Malocclusion

Occlusal characteristic	N	%	Mean habit duration (mos)	*P* value
Anterior open bite present	32	7%	55.6	<.001
Anterior open bite not present	412	93%	22.7	
Posterior crossbite present	51	12%	33.2	.048
Posterior crossbite not present	393	89%	24.0	
Excessive overjet (>4 mm) present	132	30%	28.0	.116
Excessive overjet (>4 mm) not present	308	70%	23.3	
Bilateral Class II molar relationship present	134	30%	27.6	.176
Bilateral Class II molar relationship not present	310	70%	24.0	
1 or more of the above present	244	55%	28.3	.002
None of the above present	200	45%	21.1	

children in the primary dentition. Differences in the patterns of anterior open bite may suggest that some open bites in the primary dentition may self-correct in the mixed dentition after habit cessation, but in other cases may occur in the mixed dentition in the absence of prolonged habits. In assessing changes in the prevalence of these malocclusions, it is important to remember that, while both the present study and previous findings[7,8] were from children in the same cohort, due to the exclusion of children with any permanent teeth in the primary dentition analyses and attrition from the study, the 2 groups of children are not exactly the same. Hence, group comparisons should be made with caution.

While the present longitudinal study has distinct advantages over many previous cross-sectional studies, it has its own limitations. First, while the nonnutritive sucking data were collected prospectively, due to the relatively large number of participants over a large geographic area, the answers were not individually validated. Consequently, some parents may have inaccurately reported the presence or absence of habits.

Second, while the sample was fairly large, it could not be considered to be representative of any defined, larger population. In addition, as a longitudinal study where participation declined over time, the sample generally included those most able and committed to long-term participation—those who were more educated and of higher incomes. Moreover, those who completed an adequate number of questionnaires from which the investigators were able to quantify habit duration may have had different characteristics than those who completed the questionnaires more sporadically.

Third, while the sample size was fairly large, the relatively low prevalence of prolonged habits, particularly pacifier habits beyond 48 months, limited the statistical power to detect significant differences between the various habit duration groups.

Lastly, while the making of impressions and study models is believed to be a superior means of assessing occlusal characteristics, the making of impressions may have discouraged participation of some children. It is possible that some models were incorrectly articulated, resulting in a misclassification, in spite of concerted efforts to accurately reproduce the occlusal relationships.

Conclusions

Based on this study's results, the following conclusions can be made:

1. The duration of digit habits, on average, was much longer than that of pacifier habits.
2. Malocclusion in the mixed dentition was associated with prolonged nonnutritive sucking behaviors.
3. In general, the prevalence of malocclusion increased with the duration of nonnutritive sucking.
4. In some cases, habits that ceased late in the primary dentition (ages 3 to 5 years) resulted in malocclusion in the mixed dentition.

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ABSTRACT OF THE SCIENTIFIC LITERATURE

DENTAL ABNORMALITIES IN CHILDREN WITH SUBMUCOUS CLEFT PALATE

The objective of this retrospective study was to evaluate the incidence of dental abnormalities in the permanent dentition of children with submucous cleft palate. The panoramic radiographs of 73 children (mean age=8.2 years) with submucous cleft palate were examined. Children with identified syndromes or combined clefts (cleft lip and submucous cleft palate) were excluded. Dental abnormalities were found in 36% of patients. The most frequent anomaly detected was missing teeth, seen in 16% of patients examined. A variety of other dental abnormalities were found at lower frequencies. The authors conclude that, since children with submucous cleft palate have a tendency toward increased frequency of missing teeth and other dental abnormalities, a thorough clinical and radiographic examination is especially important for these patients.

Comments: Hypodontia has been shown to be a common finding in patients with cleft palate. The fact that hypodontia and other dental anomalies also have an increased incidence in children with submucous cleft palate is an interesting finding and could be useful in the dental management of these patients. **SC**

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